

# DATA SHEET

## SURFACE-MOUNT CERAMIC EMI FILTER CAPACITORS

X2Y® Series  
6.3 V TO 100 V



**Surface-mount ceramic  
EMI filter capacitors**

**X2Y<sup>®</sup> Series**

**DESCRIPTION**

X2Y<sup>®</sup> series is a breakthrough in the design of ceramic multilayer products for decoupling and filtering in an IPD (integrated passive device).

X2Y<sup>®</sup> products comprise two identical Y-capacitors and one X-capacitor, integrated into a 4 terminal device, which is available in standard MLCC sizes. Thanks to the unique multilayer construction the device provides noise cancellation within the device, reducing ESL from nanohenry to picohenry levels.

Using the unique balance between the Y-capacitors and the shielded multilayer structure the X2Y<sup>®</sup> products offer superior decoupling and filtering.

The X2Y<sup>®</sup> device performs as a broadband filter enabling better EMC compliance for electrical equipment in a wide range of applications.

**FEATURES**

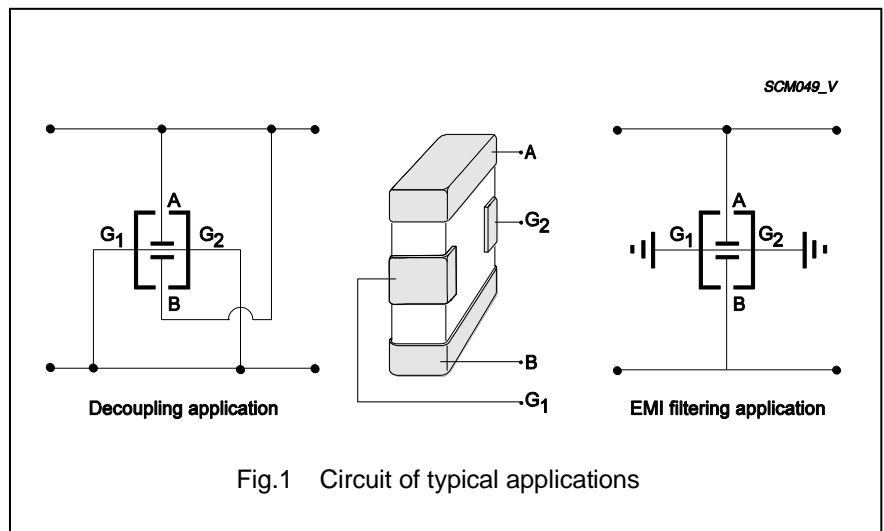
- **Broadband Filtering and Decoupling:** X2Y<sup>®</sup> is effective up to 10 GHz and frequencies beyond
- **Ultra Low ESL:** Noise cancellation within X2Y<sup>®</sup> makes ESL reducing from nanohenry to picohenry levels
- **Bypass:** Unlike feedthrough capacitors, X2Y<sup>®</sup> is in bypass, so no DC current limitations
- **Matched Y-caps:** Two tightly matched line to ground capacitors in one device
- **Superior Balance:** Temperature and voltage variations balanced of two Y-caps
- **Aging Reliability:** Aging effects are equal on two Y-caps

**BENEFITS**

- **Fewer Component in Filtering:** One X2Y<sup>®</sup> can replace multiple inductors and/or capacitors
- **Superior Performance in Filtering:** One X2Y<sup>®</sup> can eliminate both differential and common mode noises
- **Fewer Component in Decoupling:** Up to 1:7 replacement of MLCC in power delivering system bypass networks
- **Superior Performance in Decoupling:** Large or small, X2Y<sup>®</sup> components exhibit ultra low ESL
- **Total Cost Savings:** Assembly cost savings through reduced component count and placement costs
- **Board Level Design Advantages:** Dramatically reduces via drills, which blocks routing

**APPLICATIONS**

- EMI filtering on DC motors
- Filtered connectors (airbag connectors, RJ-45 connectors)
- High speed data-line filtering
- Decoupling of supply-lines in high speed digital circuits
- Broadband filtering.
- Amplifier decoupling and EMI suppression.
- IC Decoupling, on-package, on-PCB.
- DC power line filtering.
- Data line filtering.
- EMI suppression for DC motors.
- Sensors
- Audio



**Surface-mount ceramic  
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**X2Y<sup>®</sup> Series**
**QUICK REFERENCE DATA**

DESCRIPTION	VALUE
Materials	NPO / X7R / X5R
Rated voltage	
NPO	50 / 100 V
X7R	10 V, 16 V, 25 V, 50 V / 63 V, 100 V (IEC)
X5R	6.3V, 10 V
Capacitance range (Y-capacitor)	
NPO 0603 series	10 pF to 470pF
0805 series	10 pF to 47pF
X7R 0603 series	1 nF to 220 nF
0805 series	1 nF to 180 nF
1206 series	15 nF to 470 nF
1210 series	47 nF to 1 $\mu$ F
1410 series	390 nF
X5R 0603 series	220 nF to 470 nF
Tolerance on capacitance	$\pm 20\%$ (M)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04
Detailed specification	based on IEC 60384-10-1
Climatic category (IEC 60068)	X7R: 55 / 125 / 56

**Surface-mount ceramic  
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**X2Y® Series**

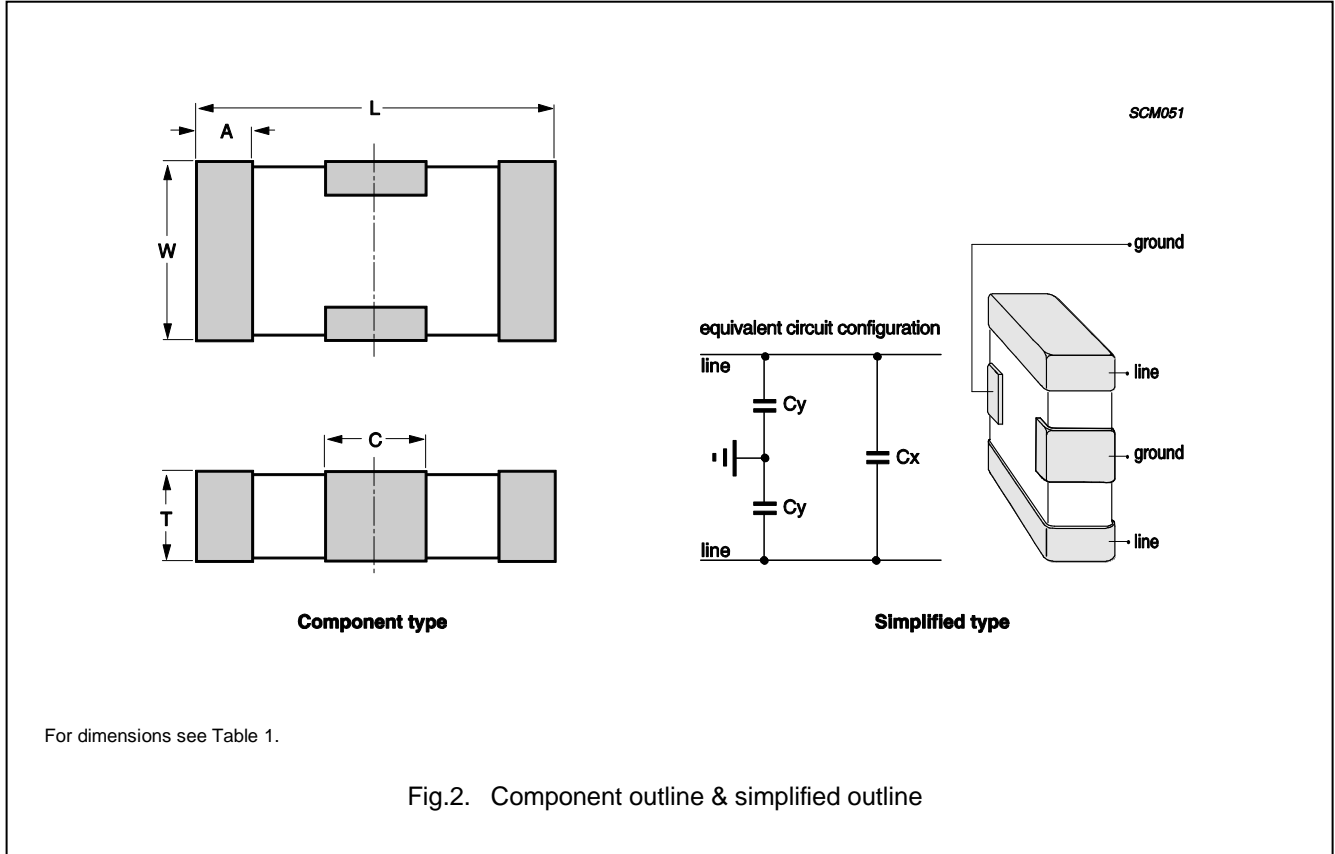
**GENERAL SELECTION CHART**

C (pF)	NPO		X7R					X5R	
	0603	0805	0603	0805	1206	1210	1410	0603	
10	100V	50V							
22									
33									
47									
100	50V								
220									
330									
1,000			100V	100 V	100 V				
1,500									
2,200									
4,700									
5,600									
10,000			50 V						
15,000			25 V	50 V	50 V				
18,000									
22,000									
39,000			16 V	25 V					
47,000					16 V				
56,000									
100,000			10 V	10 V					
180,000									
220,000									
270,000					16 V	50V			
330,000							10 V		
390,000						50V			
470,000					10 V				
560,000						25V			
820,000						16 V			
1,000,000									

**Surface-mount ceramic  
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**X2Y® Series**

**MECHANICAL DATA**



**Physical dimensions**

**Table 1** Capacitor dimensions

CASE SIZE	L	W	T		A		C
			MIN.	MAX.	MIN.	MAX.	
<b>Dimensions in millimetres</b>							
0603	1.6 ±0.15	0.85 ±0.15	0.55	0.75	0.25	0.55	0.40 ±0.20
0805	2.0 ±0.15	1.25 ±0.15	0.75	0.95	0.25	0.55	0.70 ±0.20
1206	3.2 ±0.20	1.65 ±0.20	1.10	1.40	0.25	0.65	1.20 ±0.30
1210	3.2 ±0.20	2.5 ±0.20	1.10	1.70	0.25	0.65	1.20 ±0.30
1410	3.56 ±0.25	2.5 ±0.25	1.10	1.50	0.25	0.65	1.20 ±0.30
<b>Dimensions in inches</b>							
0603	0.063 ±0.006	0.033 ±0.006	0.022	0.030	0.010	0.022	0.016 ±0.008
0805	0.079 ±0.006	0.049 ±0.006	0.030	0.037	0.010	0.022	0.028 ±0.008
1206	0.126 ±0.008	0.065 ±0.008	0.043	0.055	0.010	0.026	0.047 ±0.012
1210	0.126 ±0.008	0.098 ±0.008	0.043	0.067	0.010	0.026	0.047 ±0.012
1410	0.140 ±0.010	0.098 ±0.010	0.043	0.059	0.010	0.026	0.047 ±0.012

**Surface-mount ceramic  
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**X2Y® Series**

**ELECTRICAL CHARACTERISTICS FOR NPO**

**Class 1 capacitors; NPO dielectric; NiSn terminations**

DESCRIPTION	VALUE
Rated voltage $U_R$ (DC)	50 V , 100V
Capacitance range	10pF to 470pF
Capacitance tolerance	±20%
Tanδ ; note 1	≤ 10 x 10 <sup>-4</sup>
Insulation resistance after 1 minute at $U_R$ (DC)	$R_{ins} > 10 \text{ G}\Omega$
Temperature Coefficient	(0 ± 30) x 10 <sup>-6</sup> / K

**Note**

1. Measured at 20 °C, 1 V and 1 MHz, using a four-gauge method.

**CHARACTERISTICS FOR X7R**

**Class 2 capacitors; X7R dielectric; Ni/Sn terminations**

DESCRIPTION	VALUE
Rated voltage $U_R$ (DC)	10 V, 16 V, 25 V, 50 V/63 V ,100 V
Capacitance range	1 nF to 1 uF
Capacitance tolerance	±20%
Dissipation factor (D.F.); note 1	
6.3 V	6%
10 V	5%
16 V	3.5%
≥ 25 V	2.5%
Insulation resistance after 1 minute at $U_R$ (DC)	$R_{ins} \times C > 500$ seconds or $R_{ins} > 10\text{G}\Omega$ , whichever is less
Maximum capacitance change as a function of temperature	±15%
Operating temperature range:	
X7R	-55 °C to +125 °C
Aging	Typical 1% per time decade

**Note**

1. Measured at 20 °C, 1 V and 1 MHz, using a four-gauge method.

**Surface-mount ceramic  
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**CHARACTERISTICS FOR X5R**  
**Class 2 capacitors; X5R dielectric; Ni/Sn terminations**

DESCRIPTION	VALUE
Rated voltage UR (DC)	6.3V, 10 V
Capacitance range	220 nF to 470 nF
Capacitance tolerance	±20%
Dissipation factor (D.F.); note 1	
6.3 V	10%
10 V	10%
Insulation resistance after 1 minute at UR (DC)	$R_{ins} \times C > 500$ seconds or $R_{ins} > 10G\Omega$ , whichever is less
Maximum capacitance change as a function of temperature	±15%
Operating temperature range:	
X5R	-55 °C to +85 °C
Aging	Typical 1% per time decade

**Surface-mount ceramic  
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**X2Y<sup>®</sup> Series**

**SELECTION CHART FOR X7R SIZES 0603, 0805, 1206, 1410 <sup>(1)</sup> AND ORDERING INFORMATION**

SIZE	Y-CAPACITOR		VOLTAGE RATING (V)	THICKNESS (mm)	CTC ORDERING CODE	QUANTITY PER REEL
	CAP. (nF)	TOLERANCE (%)				
0603	1	20%	100	0.65	CX 0603 MR X7R 0BB 102	4,000
	1	20%	16	0.65	CX 0603 MR X7R 7BB 102	4,000
	1.5	20%	100	0.65	CX 0603 MR X7R 0BB 152	4,000
	1.5	20%	50	0.65	CX 0603 MR X7R 9BB 152	4,000
	2.2	20%	100	0.65	CX 0603 MR X7R 0BB 222	4,000
	4.7	20%	100	0.65	CX 0603 MR X7R 0BB 472	4,000
	5.6	20%	100	0.65	CX 0603 MR X7R 0BB 562	4,000
	5.6	20%	50 / 63	0.65	CX 0603 MR X7R 9BB 562	4,000
	10	20%	50 / 63	0.65	CX 0603 MR X7R 9BB 103	4,000
	22	20%	25	0.65	CX 0603 MR X7R 8BB 223	4,000
	47	20%	16	0.65	CX 0603 MR X7R 7BB 473	4,000
	56	20%	16	0.65	CX 0603 MR X7R 7BB 563	4,000
	100	20%	10	0.65	CX 0603 MR X7R 6BB 104	4,000
220	20%	10	0.65	CX 0603 MR X7R 6BB 224	4,000	
0805	1	20%	100	0.85	CX 0805 MR X7R 0BB 102	4,000
	4.7	20%	100	0.85	CX 0805 MR X7R 0BB 472	4,000
	10	20%	100	0.85	CX 0805 MR X7R 0BB 103	4,000
	15	20%	50 / 63	0.85	CX 0805 MR X7R 9BB 153	4,000
	18	20%	50 / 63	0.85	CX 0805 MR X7R 9BB 183	4,000
	22	20%	50 / 63	0.85	CX 0805 MR X7R 9BB 223	4,000
	22	20%	25	0.85	CX 0805 MR X7R 8BB 223	4,000
	39	20%	25	0.85	CX 0805 MR X7R 8BB 393	4,000
	47	20%	16	0.85	CX 0805 MR X7R 7BB 473	4,000
	100	20%	16	0.85	CX 0805 MR X7R 7BB 104	4,000
180	20%	10	0.85	CX 0805 MR X7R 6BB 184	4,000	
1206	15	20%	100	1.2	CX 1206 MK X7R 0BB 153	3,000
	22	20%	100	1.2	CX 1206 MK X7R 0BB 223	3,000
	47	20%	50 / 63	1.2	CX 1206 MK X7R 9BB 473	3,000
	100	20%	50 / 63	1.2	CX 1206 MK X7R 9BB 104	3,000
	220	20%	16	1.2	CX 1206 MK X7R 7BB 224	3,000
	390	20%	16	1.2	CX 1206 MK X7R 7BB 394	3,000
	470	20%	10	1.2	CX 1206 MK X7R 6BB 474	3,000
1210	100	20%	50	1.6	CX 1210 MK X7R 9BB 104	2,000
	220	20%	50	1.6	CX 1210 MK X7R 9BB 224	2,000
	390	20%	50	1.6	CX 1210 MK X7R 9BB 394	2,000
	470	20%	25	1.6	CX 1210 MK X7R 8BB 474	2,000
	560	20%	25	1.6	CX 1210 MK X7R 8BB 564	2,000
	820	20%	16	1.6	CX 1210 MK X7R 7BB 824	2,000
	1000	20%	16	1.6	CX 1210 MK X7R 7BB 105	2,000
1410	390	20%	50	1.3	CX 1410 MK X7R 9BB 394	2,000



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**SELECTION CHART FOR X5R SIZES 0603 <sup>(1)</sup>**

SIZE	Y-CAPACITOR		VOLTAGE RATING (V)	THICKNESS (mm)	CTC ORDERING CODE	QUANTITY PER REEL
	CAP. (nF)	TOLERANCE (%)				
0603	220	20%	10	0.65	CX 0603 MR X5R 6BB 224	4,000
	330	20%	10	0.65	CX 0603 MR X5R 6BB 334	4,000
	470	20%	10	0.65	CX 0603 MR X5R 6BB 474	4,000
	470	20%	6.3	0.65	CX 0603 MR X5R 5BB 474	4,000

**Notes**

1. Other values are available on request.

**SELECTION CHART FOR NPO SIZES 0603,0805 <sup>(1)</sup>**

SIZE	Y-CAPACITOR		VOLTAGE RATING (V)	THICKNESS (mm)	CTC ORDERING CODE	QUANTITY PER REEL
	CAP. (nF)	TOLERANCE (%)				
0603	0.01	20%	100	0.85	CX 0603 MR NPO 0BB 100	4,000
	0.022	20%	100	0.85	CX 0603 MR NPO 0BB 220	4,000
	0.033	20%	100	0.85	CX 0603 MR NPO 0BB 330	4,000
	0.047	20%	100	0.85	CX 0603 MR NPO 0BB 470	4,000
	0.1	20%	50	0.85	CX 0603 MR NPO 9BB 101	4,000
	0.22	20%	50	0.85	CX 0603 MR NPO 9BB 221	4,000
	0.47	20%	50	0.85	CX 0603 MR NPO 9BB 471	4,000
0805	0.01	20%	50	0.85	CX 0805 MR NPO 9BB 100	4,000
	0.022	20%	50	0.85	CX 0805 MR NPO 9BB 220	4,000
	0.047	20%	50	0.85	CX 0805 MR NPO 9BB 470	4,000

**Notes**

1. Other values are available on request.

**THICKNESS CLASSIFICATION AND PACKING QUANTITIES FOR X7R**

THICKNESS CLASSIFICATION (mm)	QUANTITY PER REEL				
	8 mm TAPE WIDTH				12 mm TAPE WIDTH
	∅ 180 mm; 7"		∅ 330 mm; 13"		∅ 180 mm; 7"
	0603 - 1410				1812
	PAPER	BLISTER	PAPER	BLISTER	BLISTER
0.65 ±0.1	4,000				
0.85 ±0.1	4,000				
1.2 ±0.15	–	3,000			
1.6 ±0.15	–	2,000			
1.3 ±0.5		2,000			

**Surface-mount ceramic  
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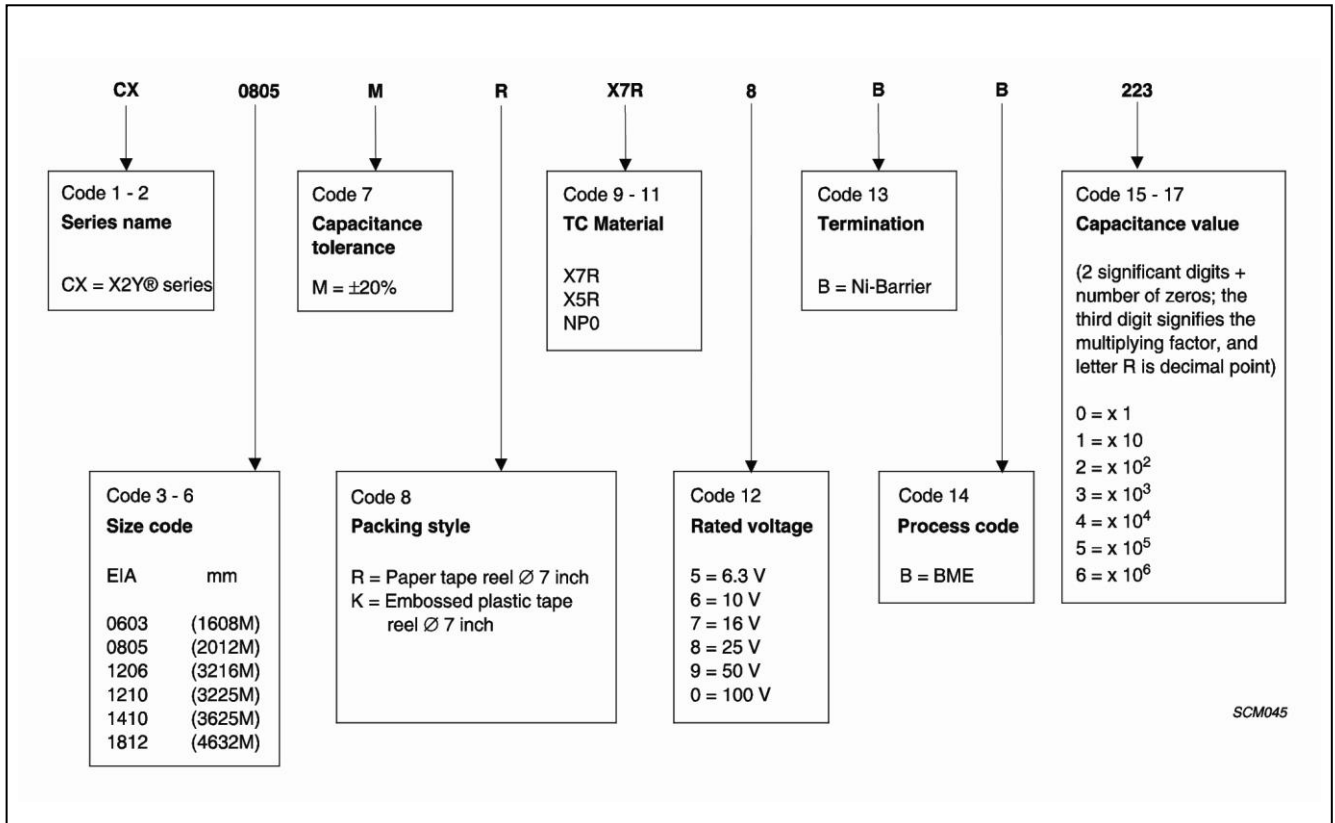
**X2Y® Series**

**ORDERING INFORMATION**

Components may be ordered by using either a Yageo part number or Phycomp's unique 12NC.

**Ordering code: Yageo part number**

**Example: CX0805MRX7R8BB223**



**Surface-mount ceramic  
EMI filter capacitors**

**X2Y® Series**

**RECOMMENDED DIMENSIONS OF SOLDER LANDS**

**Table 3** Reflow soldering

CASE SIZE (EIA)	Footprint dimensions (mm)					Placement Accuracy (mm)
	A	B	C	D	E	
0603	2.30	0.76	0.64	0.51	1.52	±0.20
0805	3.05	1.27	0.89	0.56	2.03	±0.20
1206	4.06	1.65	1.00	1.02	3.05	±0.25
1210	4.57	2.55	1.00	1.14	4.06	±0.25
1410	4.57	2.55	1.00	1.14	4.06	±0.25

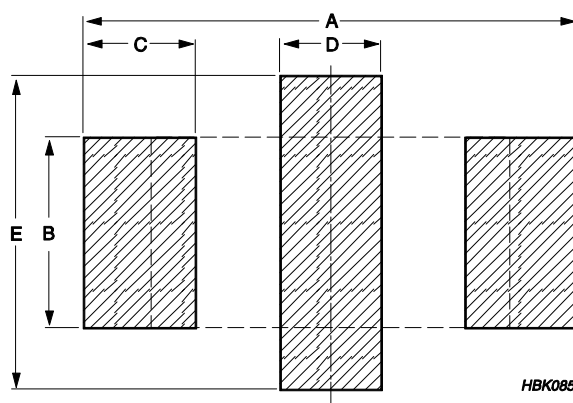


Fig.3 Recommended dimensions of solder lands

**Surface-mount ceramic  
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**X2Y® Series**

**MEASUREMENT SETUP**

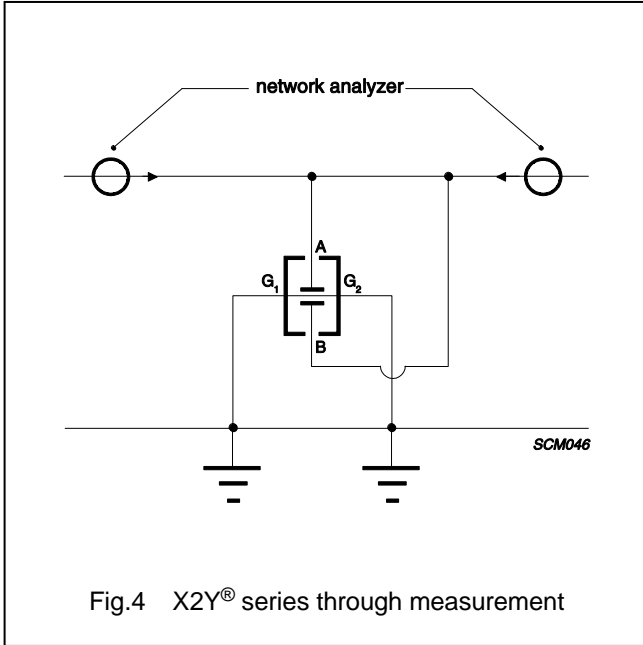


Fig.4 X2Y® series through measurement

- X2Y® are soldered on a printed circuit board
- PCB: FR-4 substrate, with 50 Ω microstrip line
- Network Analyzer: Agilent E5071b
- Calibration: full 2-port calibration with 85033E kit

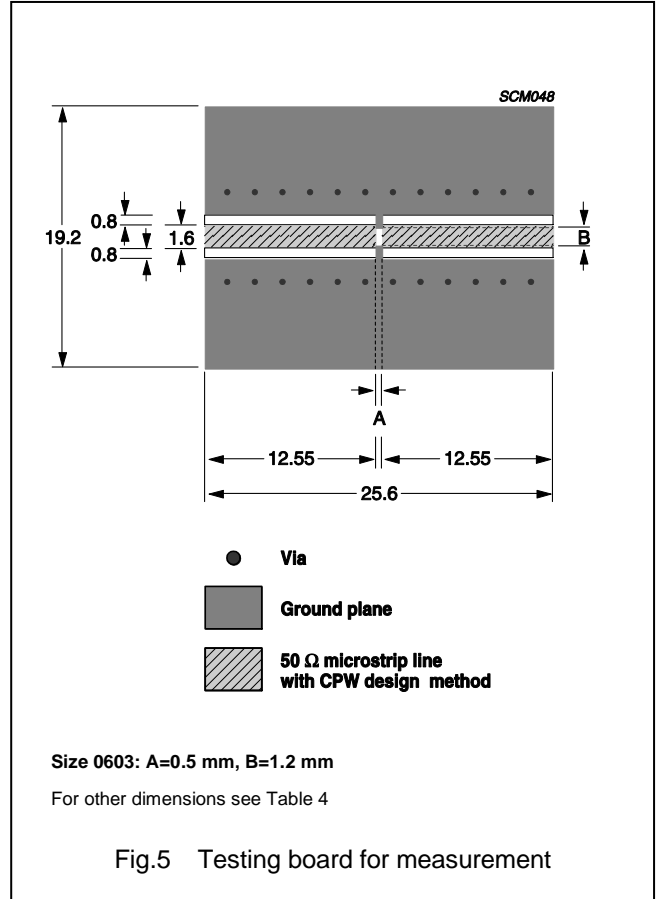


Fig.5 Testing board for measurement

**Table 4** Recommended dimensions of measurement

CASE SIZE	A (mm)	B (mm)
0603	0.5 ±0.10	1.2 ±0.10
0805	0.8 ±0.10	1.6 ±0.10
1206	1.2 ±0.10	2.8 ±0.15
1210	2.1 ±0.15	2.8 ±0.15
1410	2.1 ±0.15	3.1 ±0.15

**Surface-mount ceramic  
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**X2Y<sup>®</sup> Series**

**TESTS AND REQUIREMENTS**

**Table 5** Test procedures and requirements

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2	TEST	PROCEDURE	REQUIREMENTS
	TEST METHOD			
4.4		mounting	the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying reflow soldering (including vapor phase soldering) or conductive adhesive	no visible damage
4.5		visual inspection and dimension check	any applicable method using $\times 10$ magnification	in accordance with specification
4.6.1		capacitance	Class 1: $\leq 1000$ pF; $f = 1$ MHz $>1000$ pF; $f = 1$ kHz NP0: measuring voltage 1 V at 20 °C Class 2: For all capacitors $f = 1$ kHz X7R: measuring voltage 1 V at 20 °C Y5V: measuring voltage 1 V at 25 °C	within specified tolerance
4.6.2		$\tan \delta$	Class 1: $\leq 1000$ pF; $f = 1$ MHz $>1000$ pF; $f = 1$ kHz NP0: measuring voltage 1 V at 20 °C Class 2: For all capacitors $f = 1$ kHz X7R: measuring voltage 1 V at 20 °C Y5V: measuring voltage 1 V at 25 °C	in accordance with specifications
4.6.3		insulation resistance	at UR (DC) for 1 minute	in accordance with specification
4.6.4		voltage proof	$2.5 \times$ UR for 1 minute	no breakdown or flashover
4.7.1		temperature characteristic	Between minimum and maximum temperature	in accordance with specification
4.8		adhesion	a force of 5 N applied for 10 s to the line joining the terminations and in a plane parallel to the substrate	no visible damage

**Surface-mount ceramic  
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**X2Y<sup>®</sup> Series**

**Table 5** Test procedures and requirements (continued)

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2	TEST	PROCEDURE	REQUIREMENTS
	TEST METHOD			
4.9		bond strength of plating on end face	mounted in accordance with CECC 32 100, paragraph 4.4	no visible damage
			conditions: bending 1 mm at a rate of 1 mm/s, radius jig 340 mm	$\Delta C/C$ : class 1: within $\pm 10\%$ class 2, X7R: within $\pm 10\%$ class 2, Y5V: within $\pm 30\%$
4.10	Tb	resistance to soldering heat	Precondition: 120 to 150 °C for 1 minute; 260 $\pm 5$ °C for 10 $\pm 0.5$ s in a static solder bath	the terminations shall be well tinned after recovery $\Delta C/C$ : class 1: within $\pm 0.5\%$ or 0.5 pF whichever is greater class 2, X7R: $> -5\%$ and $\leq 10\%$ class 2, Y5V: $> -10\%$ and $\leq 20\%$
		resistance to leaching	260 $\pm 5$ °C for 30 $\pm 1$ s in a static solder bath	using visual enlargement of $\times 10$ , dissolution of the terminations shall not exceed 10%
4.11	Ta	solderability	zero hour test, and test after storage (20 to 24 months) in original packing in normal atmosphere; unmounted chips completely immersed for 2 $\pm 0.5$ s in a solder bath at 235 $\pm 5$ °C	the terminations shall be well tinned
4.12	Na	rapid change of temperature	Preconditioning, class 2 only; NP0 / X7R: $-55$ to $+125$ °C; 5 cycles Y5V: $-25$ to $+85$ °C; 5 cycles	no visual damage after 48 hours recovery; $\Delta C/C$ : class 1: within $\pm 1\%$ or 1 pF class 2, X7R: within $\pm 15\%$ class 2, Y5V: within $\pm 20\%$
4.15		Endurance	Pre-conditioning, class 2 only: 1000 hours at upper category temperature at: 1.5 $\times$ UR	no visual damage after 24 hours recovery: $\Delta C/C$ : class 1: within $\pm 2\%$ or 1 pF, whichever is greater class 2, X7R: within $\pm 20\%$ class 2, Y5V: within $+30/-40\%$ tan $\delta$ : class 1: $\leq 2 \times$ specified value class 2: X7R: $\leq 7\%$ class 2: Y5V: $\leq 15\%$ Rins: class 1: 4000 M $\Omega$ or Rins $\times$ CR $\geq 40$ s, whichever is less class 2: 2000 M $\Omega$ or Rins $\times$ CR $\geq 50$ s, whichever is less

**Surface-mount ceramic  
EMI filter capacitors****X2Y<sup>®</sup> Series****REVISION HISTORY**

<b>Revision</b>	<b>Date</b>	<b>Change Notification</b>	<b>Description</b>
Rev.5	2001 Sep 25	-	- Published on web
Rev.6	2002 Jul 10	-	- Product range extended in all materials and sizes; - Insertion loss measurements added.
Rev.7	2003 Apr 02	-	- Updated company logo
Rev.8	2003 Jul 23	-	- Cover page revised
Rev.9	2003 Sep 09	-	- Cover page corrected
Rev.10	2004 Apr 21	-	- Product range updated - NP0, Y5V and size 1812 removed.
Rev.11	2006 Nov 21	-	- Size 1410 extended - Product applications, features and benefits update - Measurement setup added - Updated tests and requirements
Rev.12	2006 Dec 22	-	- 12 NC revised
Rev.13	2008 Nov 10	-	- Product range extended in materials of NP0 and X5R
Rev. 14	2013 June 27		- Rev.14 : Product range extended on NP0 0606 and 0805